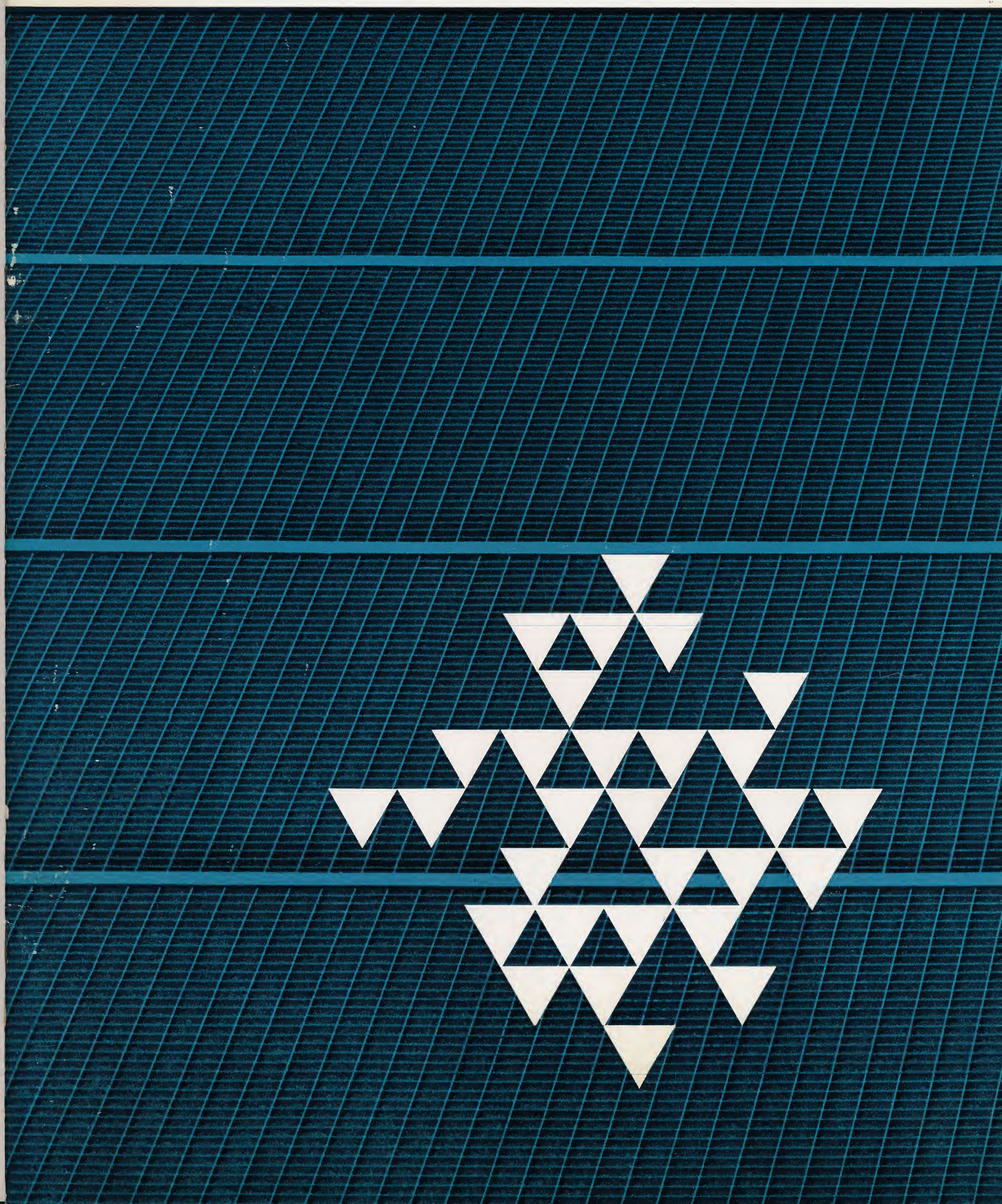
SYSTEM DEVELOPMENT CORPORATION



THE SPECIFIC AND PRIMARY PURPOSES

FOR WHICH THE CORPORATION IS FORMED

ARE TO RECEIVE AND ADMINISTER FUNDS

AND PROPERTY EXCLUSIVELY FOR

SCIENTIFIC, EDUCATIONAL, AND CHARITABLE PURPOSES

FOR THE PUBLIC WELFARE AND SECURITY

OF THE UNITED STATES OF AMERICA...

*—Articles of Incorporation*

Present day military, industrial and business operations are conducted on an unprecedented scale over great physical distances and under increasing pressure of time. Centralized management of such operations has become more and more difficult as the volume of information that must be collected, sorted, summarized and reported to the managers has increased. The management decisions that must be made may have far-reaching consequences and may involve huge risks.

This development in human affairs has led to evolution of the "control system," a complex of machines and human beings formed to collect, process, transmit and display data concerning events taking place at widely separated locations, to take action to control the events and to provide the managers of an organization with the facts they need for decisions affecting its total mission. The control system must function in real time, observing, controlling and reporting events as they occur.

Modern high-speed electronic digital computers are essential elements of large real-time control systems. Their tremendous speed, capacity and accuracy enable them to handle huge masses of information in the short time periods that may be available for action. In some instances the state of the art has advanced to the point where they can be used to control situations automatically, as in the case of missile guidance or the "automatic factory," with only occasional assistance from human monitors.

Human beings are still essential elements of most control systems. At many levels within a control system, they are needed to perform those functions requiring judgment, imagination or intuition that machines cannot presently be made to perform.

Large scale, real-time computer-based control systems are the unique specialty of the System Development Corporation. At SDC, many branches of technical and management knowledge are combined in an interdisciplinary team approach to the development of systems. A specialized technology has evolved to match control systems to the requirements of their users, exploit the power of data-processing machines, and make the most effective use of human beings functioning within such systems.

Simulation, from abstract mathematical models to replication of real events in real time, is used extensively by SDC to design, evaluate and test systems and their components. Simulation is also important to the methods, procedures and materials that are created for training and exercising the humans who perform functions within a control system or who use it. Advanced data processing techniques are applied to the creation of computer programs for decision-making and control.

SDC is an independent, non-profit corporation, formerly the System Development Division of The RAND Corporation, and has its main offices in Santa Monica, California. SDC operations are conducted on a nation-wide scale, with representatives or offices in nearly every state.

The following pages describe the organization of the corporation and some aspects of its present work in developing control systems.

## MANAGEMENT

A Board of Trustees, composed of leaders in science, industry and public life, establishes the policies that guide the System Development Corporation and its more than 3,200 employees. The Board is informed of the progress of SDC's work by periodic reports and briefings. When the Board is not in session, an Executive Committee functions in its place.

F. R. COLLBOHM

J. R. GOLDSTEIN

Members of the Board of Trustees are:

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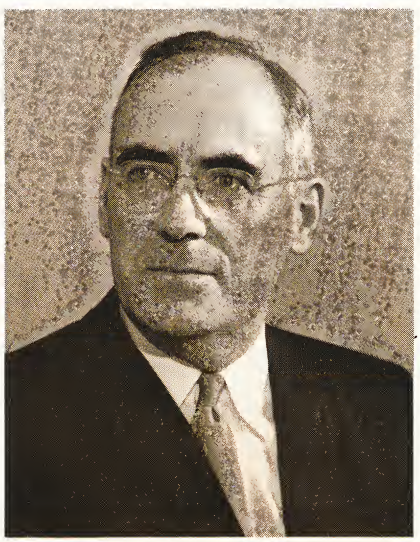


W. W. PARSONS

## PRESIDENT AND VICE PRESIDENTS

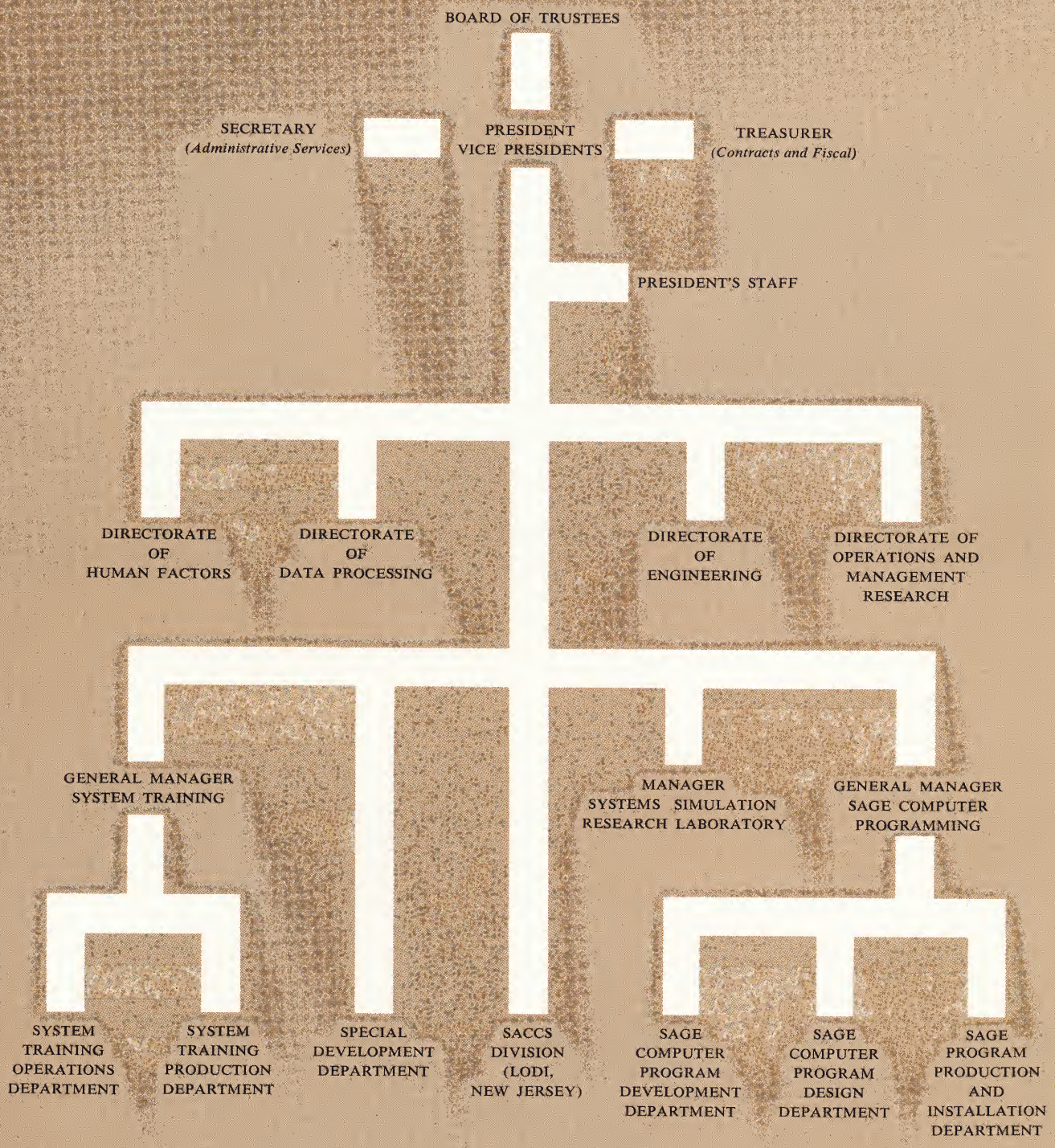
The policies established by the Board of Trustees are carried out in daily management of SDC by the President and Vice Presidents of the Corporation.

The President of the System Development Corporation is M. O. Kappler, an electronics engineer with training in the sciences and in business administration, and with broad experience in the civilian and military aspects of each. Prior to the formation of SDC, Mr. Kappler was Assistant Head of the Electronics Division of The RAND Corporation and later Co-Chief of RAND's System Development Division.

One of the Vice Presidents of SDC, Dr. W. C. Biel, is a psychologist with a diversified background in teaching, psychological research, military psychology, and industrial consulting. Dr. Biel served with Mr. Kappler as Co-Chief of RAND's System Development Division.

The other Vice President, William W. Parsons, came to SDC from a career of public service with the Bureau of the Budget and the Treasury Department of the United States, where he served for many years as Administrative Assistant Secretary of the Treasury. His background includes training in business and public administration.

The President and Vice Presidents are assisted by the Corporation Secretary and Treasurer, the President's Staff, and the Management Council.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(Administrative Services)
PRESIDENT
VICE PRESIDENTS
TREASURER
(Contracts and Fiscal)
PRESIDENT'S STAFF
DIRECTORATE OF HUMAN FACTORS
DIRECTORATE OF DATA PROCESSING
DIRECTORATE OF ENGINEERING
DIRECTORATE OF OPERATIONS AND MANAGEMENT RESEARCH
GENERAL MANAGER SYSTEM TRAINING
MANAGER SYSTEMS SIMULATION RESEARCH LABORATORY
GENERAL MANAGER SAGE COMPUTER PROGRAMMING
SYSTEM TRAINING OPERATIONS DEPARTMENT
SYSTEM TRAINING PRODUCTION DEPARTMENT
SPECIAL DEVELOPMENT DEPARTMENT
SACCS DIVISION (LODI, NEW JERSEY)
SAGE COMPUTER PROGRAM DEVELOPMENT DEPARTMENT
SAGE COMPUTER PROGRAM DESIGN DEPARTMENT
SAGE PROGRAM PRODUCTION AND INSTALLATION DEPARTMENT


SDC
SYSTEM DEVELOPMENT CORPORATION
RTA 021

## THE PRESIDENT'S STAFF

The President's Staff is made up of the Assistants to the President, the Liaison Office, and the Office of Public and Technical Information. Some of the functions of the President's Staff are to handle the preliminary work leading to new Corporation activities, to represent SDC at the headquarters of other organizations, to establish policies for the dissemination of information within and outside the Corporation, and to keep the President informed on the progress of SDC's technical activities.

## MANAGEMENT COUNCIL

All of the Corporation's professional skills and major activities are represented on the Management Council, which meets rgularly with the President and Vice Presidents to deal with corporate planning and technical and administrative matters. It consists of the President, Vice Presidents, Secretary and Treasurer of the Corporation and the heads of the four Directorates.

J. H. BERKSON, *Treasurer;* L. F. CARTER, *Director of Human Factors;*
D. G. MALCOLM, *Director of Operations and Management Research;*
L. G. TURNER, *Secretary;* F. G. SUFFIELD, *Director of Engineering;*
J. D. MADDEN, *Director of Data Processing*

## DIRECTORATES

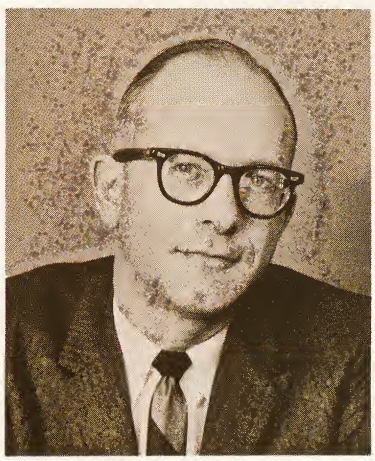
The Corporation's technical staff includes four major professional specialties: Data Processing, Human Factors, Engineering, and Operations and Management Research. These are drawn from a wide variety of academic fields—the social and behavioral sciences, pure and applied mathematics, aeronautics, physics, geography, meteorology and statistics. SDC's prime resource is its professional staff, which includes more than 1,500 college graduates and 500 holders of advanced degrees. Effective use and planned growth of the staff are the major responsibilities of the Directors.
Each Director is concerned with over-all corporate plans and commitments as well as with the earnings and professional climate for those of his own and related skills. He ensures that qualified professional personnel in his area of responsibility are available to each Department as needed for specific contractual operations and that future plans provide for the continued employment of people in his skill area. The activities of the Directorates cross-cut those of the Departments, not only with respect to personnel requirements, but also with respect to research. The Directorates are responsible for contract-related research, as well as for SDC-sponsored research in their particular skill areas. The general research policies of the Corporation are established by the Research Committee, which consists of the Vice President and the four Directors.

# DEPARTMENTS AND DIVISIONS

M. G. HOLMEN *(center), General Manager of System Training, and his Department Heads,* A. I. BENSON *and* E. RUNDQUIST

W. S. MELAHN *(second from left), General Manager SAGE Computer Programming and his Department Heads,*
B. E. MORRISS, H. D. BENINGTON and J. F. MATOUSEK

SDC's Departments and Divisions carry the responsibility for performance of contractual operations. The professional staff of each Department or Division is determined by the needs of the contract for which it is responsible, and is drawn from the Directorate skill areas. A Department or Division, or a group of several Departments under a General Manager, is established for each long-term contract, such as SAGE Computer Programming and the System Training Program. Specific personnel needs may occasionally change within each Department to accommodate changes in or expansions of the contract for which it is responsible. Applied research and development, which are part of the requirements of their respective contracts, are conducted in the Departments and Divisions.



R. G. LEITNER, *Special Development Department Head (left)*
H. R. PATTON, *Head of SACCS Division*

Preliminary operations on new commitments which may ultimately lead to formation of new Departments or Divisions, and smaller-scale contracts are handled by the Special Development Department.

The SACCS (Strategic Air Command Control System) Division at Lodi, New Jersey, was established to carry out SDC's responsibilities in the development of a control system for SAC.

## PROFESSIONAL SKILLS

SDC's work requires the application of many basic professional skills; among these skills four major areas exist, each the responsibility of a Directorate in the Corporation.

## DATA PROCESSING

The electronic computers that are the machine elements of most large-scale data-processing systems operate by means of detailed sets of coded instructions called computer programs. Data Processing specialists at SDC conduct long-range studies into the most efficient and economical uses of computers and their associated input and output equipment. They also design, write, test, produce, install, revise, and maintain the computer programs themselves. In addition, research is conducted in such areas as automatic data processing, automatic control technology, and mathematical and logical symbology.

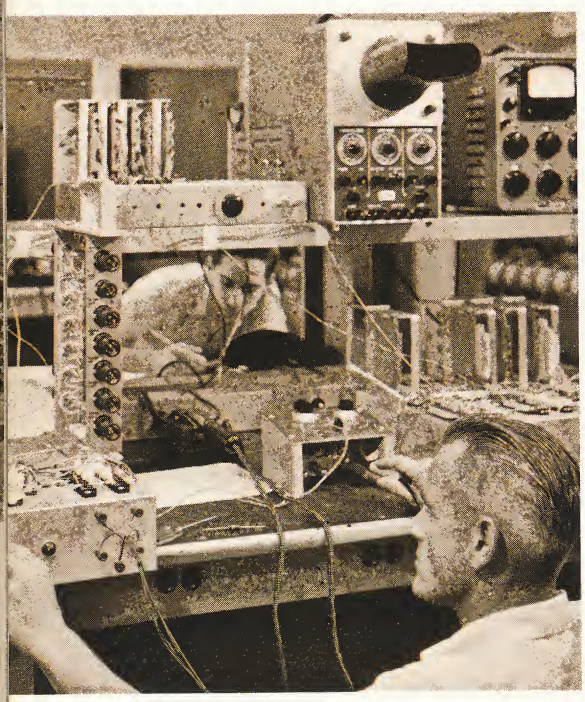
SDC's data processing personnel include the largest staff of computer programmers in the United States, as well as specialists in mathematics, engineering, and computer-system formulation.

## HUMAN FACTORS

Human Factors scientists at SDC study the human elements of control systems and look for the optimum balance of man and machine capabilities; they study system environment, and develop training programs that help men to perform effectively in these environments. SDC carries on a long-range research program into all aspects of man-machine relationships. Specialists collect the detailed information required for realistic simulation of a system's actual or potential environment, and design training exercises that will stress critical functions of all or parts of the system. After the training design phase, consultation is provided during the actual operation of a training program. As new training techniques are developed, they are tested in SDC's simulation laboratories or in the field under conditions of actual operations. SDC utilizes the skills of specialists in human engineering, learning, organizational theory, group dynamics, experimental psychology and other fields of human behavior. SDC emphasis on the human element of system operation has led to employment of one of the largest staffs of behavioral scientists to be found in the country.

## ENGINEERING

Engineers at SDC are primarily concerned with the analysis and evaluation of machine elements of systems. They analyze the present and potential capabilities of weapons, communication equipment, guidance and control systems, and analog and digital computers. A major equipment addition, such as a guided missile which is to be integrated with a control system, requires thorough knowledge of the missile's guidance system and performance characteristics. Estimates must be made of the probable effect that the new element will have on the over-all control system. Engineers study and solve these problems, which often require designing simulation devices and special-purpose equipment. Development of advanced engineering models of equipment is conducted in mechanical engineering and communications laboratories, and in facilities for digital, photochemical, and electrical-optical study.



## OPERATIONS AND MANAGEMENT RESEARCH

Teams of operations-research specialists at SDC analyze and evaluate large-scale military, governmental and industrial systems, and conduct research into management operations. System requirements are analyzed, system objectives established, problems stated, possible solutions examined, and the most practical solution – in terms of cost and effectiveness – determined. As part of an SDC-sponsored research program, an analysis is being made of potential applications of control systems to the decision-making function in management. The findings of this study will be broadly shared with other organizations.

# WORK IN PROGRESS

## AIR DEFENSE

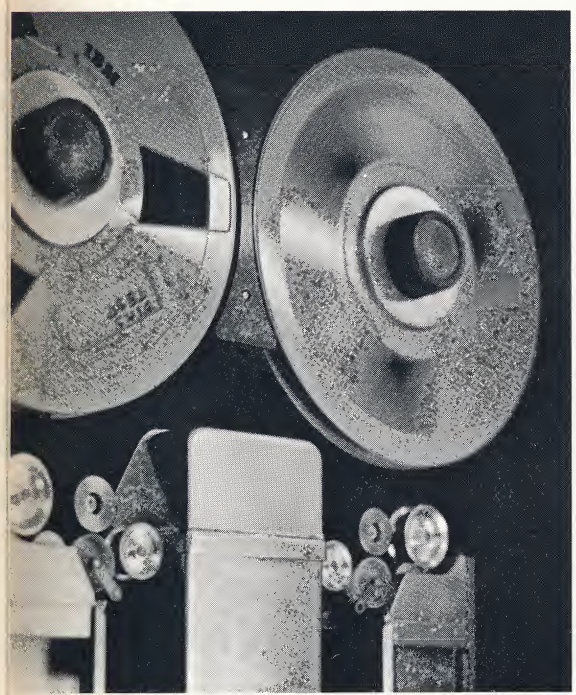
Defending North America against air attack is the mission of the North American Air Defense Command (NORAD), a multiservice joint command of the United States and Canada. The United States Air Force component of NORAD is the Air Defense Command, ADC, which has responsibility for detecting airborne objects, identifying them as friendly or hostile before they penetrate critical areas of the continent, and for sending up defensive weapons early enough to protect against known hostiles. For effective protection, an air defense system must not only be able to monitor flights entering the continent from all directions, but must also incorporate both great speed – to handle enormous masses of data in the very short critical period that might precede hostile attack – and great accuracy – to eliminate human error where the threat of nuclear weapons is present. The personnel of the air defense system who are responsible for tactical action must have at their disposal detailed information on every airborne object within the continent or approaching its borders, on the numbers and locations of defensive weapons and on pertinent weather conditions over a tremendous geographic area. In addition, communication between defensive installations must be rapid and efficient.

The facilities of ADC, which support its air defense mission, include the 9,000-mile DEW line across the northern reaches of the continent; a continent-ringing network of radar stations with air and seaward extensions; fighter-interceptor squadrons, many equipped with atomic weapons capable of destroying entire formations of enemy bombers; and missile sites. The system that ADC has chosen to monitor, coordinate, and control the activities of its far-flung detection and defensive weapons is the SAGE (Semi-Automatic Ground Environment) System.

SAGE is a new, highly automatic system that uses a network of high-speed electronic digital computers to provide the speed and accuracy necessary for air defense, to process the great volumes of incoming data, to interpret these data and present clear summary information to operations personnel, to calculate complicated mathematical interception problems, and to provide guidance to defense weapons. SAGE is one of the most advanced control systems in the modern world, but the computers that are the core of the system cannot operate without programs – detailed instructions that tell them what to do and when to do it.

SAGE COMPUTER PROGRAMMING

The development, production, installation, and continual improvement of the SAGE computer program, and the adaptation of this program to the environments of more than 30 SAGE Direction Centers and Combat Centers throughout the United States are major tasks of the System Development Corporation. New models – more sophisticated versions – of the program are periodically developed by SDC, checked exhaustively for satisfactory operation, and introduced at the SAGE sites. Each successive model reflects advanced knowledge gained from SDC data-processing research studies and incorporates new developments in tactics, operational defensive weapons, and equipment. The computer programs that SDC prepares for the SAGE System are the most extensive ever written. The basic program that enables each SAGE

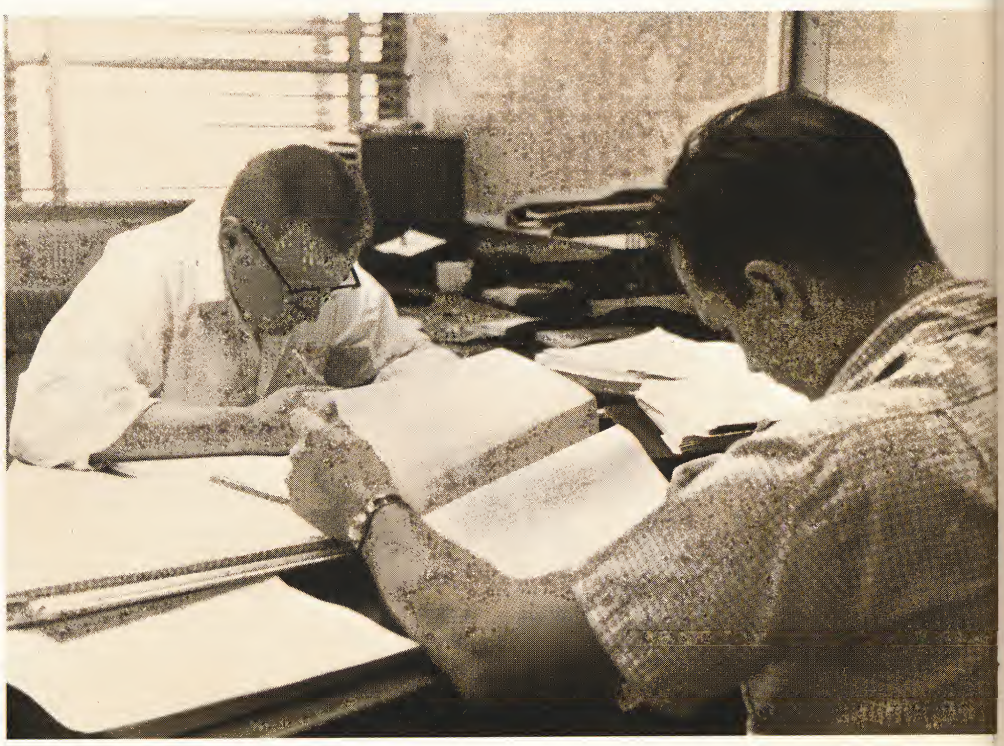


computer to perform its air defense tasks consists of about 70,000 individual coded instructions; other programs totalling 180,000 additional instructions are required for data recording and reduction, simulation, training, and other support functions. All these related programs must operate in concert. The development, design, preparation, testing and installation of these huge interleaved, real-time computer programs is an undertaking without precedent in the history of digital computing.

THE SYSTEM TRAINING PROGRAM

The Air Defense Command's System Training Program (STP) began as an experimental study of the human factors affecting the performance of man-machine systems. STP exercises simulate, for air defense personnel, the conditions of emergency situations – such as air attack – with which a control system may be required to deal. These simulated exercises provide the air defense system with practice in dealing with stress situations it would not ordinarily meet in daily operations, and may be designed to emphasize particular factors – such as heavy traffic loads or geographic problems – peculiar to individual locations. Because STP exercises are planned, controlled, and closely observed, they make possible evaluations of human performance under stress conditions; such evaluations, analyzed and discussed, lead to improvements in performance and efficiency of the over-all system. STP materials – hundreds of aids such as charts, maps, film, magnetic tape, and scripts – are largely machine-produced by SDC computing equipment; more than a billion calculations are performed annually to maintain a steady output of varied and increasingly complex training exercises.

STP has been installed at more than 150 individual radar sites throughout the continental U. S. and Canada and further geographical extensions are in progress. In addition, SDC has extended the System Training Program for use in training Air Force personnel at all command echelons responsible for the operation of the SAGE system. Constant improvements and refinements in STP improve training and adapt the program to new equipment and procedures as they are introduced into the air defense system.



STRATEGIC AIR COMMAND CONTROL SYSTEM

In case of declaration of war or enemy attack on the United States, the quick and effective destruction of the enemy's productive and military capacity is the mission of the United States Air Force's Strategic Air Command (SAC). For this reason, SAC equipment and men are situated around the globe, ready to retaliate at a moment's notice.

Effective control of this powerful retaliatory force requires that SAC Headquarters be constantly aware of the readiness and weapons status at each SAC base; of the locations and capabilities of all SAC bombers; of the locations of the enemy's critical facilities; of the enemy's major troop and plane movements; and of world-wide weather conditions. SAC Headquarters must be able to use this information to make rapid and accurate decisions, and to maintain communication with all SAC bases and bombers.

The SAC Control System (SACCS) is designed to meet this need. As a participant in the over-all development of this system, SDC provides system analysis of SAC operations, and designs and writes the programs for the high-speed digital computers that process information received from SAC bases and forwarded, in both detailed and summarized form, to SAC Headquarters. SDC's function in SACCS includes applications of simulation techniques and other aspects of man-machine system technology to major components of the system. SDC is also developing system training programs and operating instructions for the SAC Control System.

### FIELD OPERATIONS

Several of SDC's commitments require work in the field to supplement initial system development. For this purpose, the Corporation carries on extensive field operations. For example, after system training is installed in the field by SDC and the military personnel who will participate in it are familiarized with its uses, permanent SDC representatives remain in the field as consultants in the continuing operation of the training program. Many SDC programmers also work directly in the field with the organizations using digital-computers; they install computer programs and check them for satisfactory operation; and a group of programmers remains at each location to maintain the program and introduce later revisions.

These field representatives provide a feedback mechanism for SDC, advising the home office of requirements for changes in training or computer programs and reporting problems in system operation that require home office action. The field organization represents about one-third of the total strength of the Corporation.

### OTHER CONTRACT OPERATIONS

In addition to its work for Air Defense Command and Strategic Air Command, SDC is currently working on several smaller contracts for other agencies and organizations.

### SELF-SPONSORED RESEARCH

Part of SDC's income from contract operations is used to sponsor research in the public interest; members of the professional staff are encouraged to propose research projects that can be supported by Corporation income. SDC's self-sponsored research includes study of business management control systems, involving the application of digital computers to the decision-making function in business; a study of the possible applications of computing machines to instruction, including research into and evaluation of various automated-teaching techniques that have already been developed; and research in medical data processing that may point the way to use of the tremendous capacities and versatility of digital computers for compiling and making widely available medical histories, diagnoses, and treatments. Further, SDC is supporting the writing of several books in technical fields relevant to the work of the Corporation – data processing, digital computing, and statistical analysis, for example.

## SYSTEMS SIMULATION RESEARCH LABORATORY

Scheduled for completion in mid-1961, the Systems Simulation Research Laboratory will be a facility designed for basic research by all the Directorates into general principles of systems.

In addition to adding to our basic knowledge about systems, research in the lab is expected to contribute to better understanding of simulation as a tool in the study, planning, and design of such systems.

The SSRL, as it is called, is unique in that it is truly inter-disciplinary and general-purpose, seeking basic principles about systems, rather than isolated facts about a specific referent system.

The largest laboratory ever built at SDC, it will occupy about 20,000 square feet when completed. It will be centered around a large-scale digital computer, linked to a specially-designed data-transfer device.

Simulation methods will range from symbolic programmed models to real-time facsimile representations, and the systems studied may vary from highly generalized social processes to very specific military command control systems. The research will be conducted by joint teams from the four Directorates in conjunction with the Laboratory staff. Outstanding research scientists throughout the nation will also be invited to participate in projects.

## FACILITIES

Two of the three modern buildings in Santa Monica (with more than 500,000 square feet of floor space) that house the System Development Corporation are devoted to offices, computing areas, and departmental laboratories; they also contain communications, maintenance, and other support facilities. The third building houses a SAGE computer and its associated equipment, and a Simulation Laboratory. An additional building, of more than 200,000 square feet, will soon be erected to accommodate SDC's planned growth.

With three high-speed digital computers – the duplexed SAGE computer and IBM 704 and 709 computers – SDC has one of the largest and most flexible computing facilities in the country. Its computers are supplemented with extensive accessory equipment; most of this is standard equipment modified to SDC's own specifications. Soon to be added is a transistor version of the SAGE computer, also a duplex installation; an IBM Model 7090 computer is also on order. With these additions, SDC's computing capacity will be more than doubled.

The Corporation has part-time use (for SAGE system research) of the air defense Direction Center at Grandview, Missouri. SDC also has two major laboratory facilities for research and development in Santa Monica. The Simulation Laboratory is completely equipped for realistic simulations of potential system environments; a Human Factors Laboratory is designed for research into group behavior.

SYSTEM DEVELOPMENT CORPORATION

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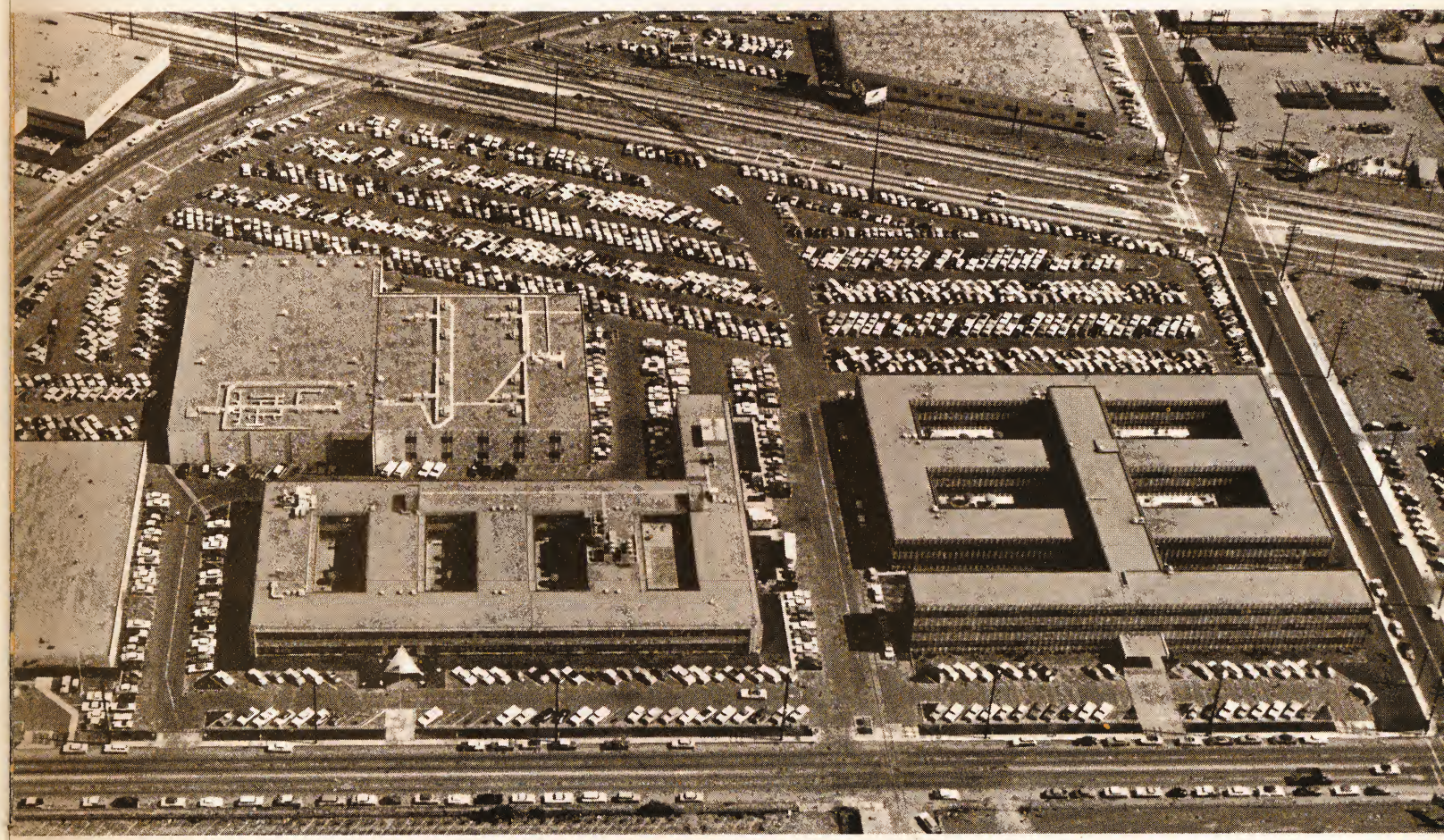
SANTA MONICA, CALIFORNIA




SDC